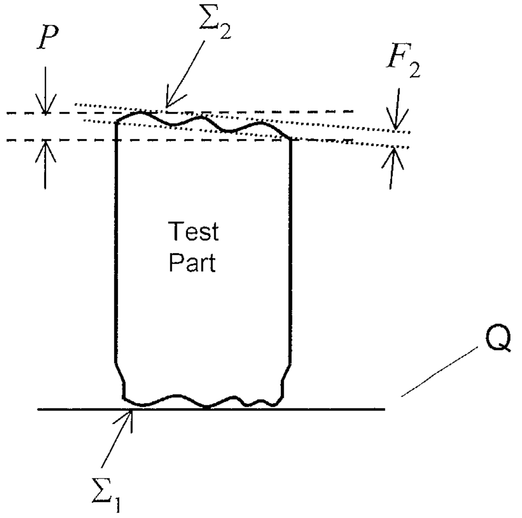

Figure 1

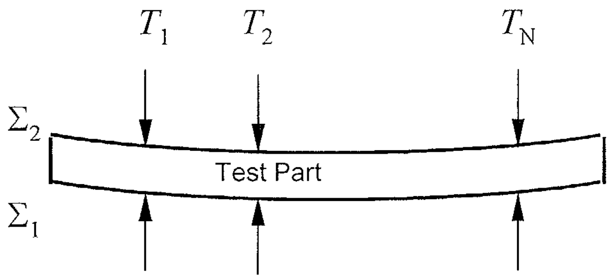

Figure 2

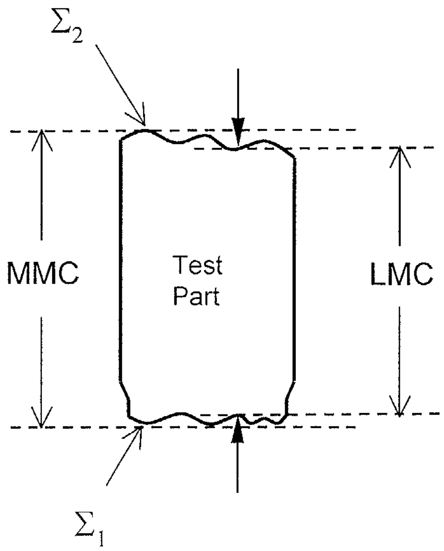

Figure 3

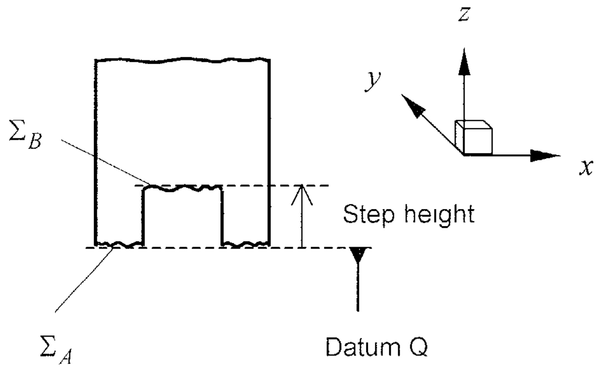

Figure 4

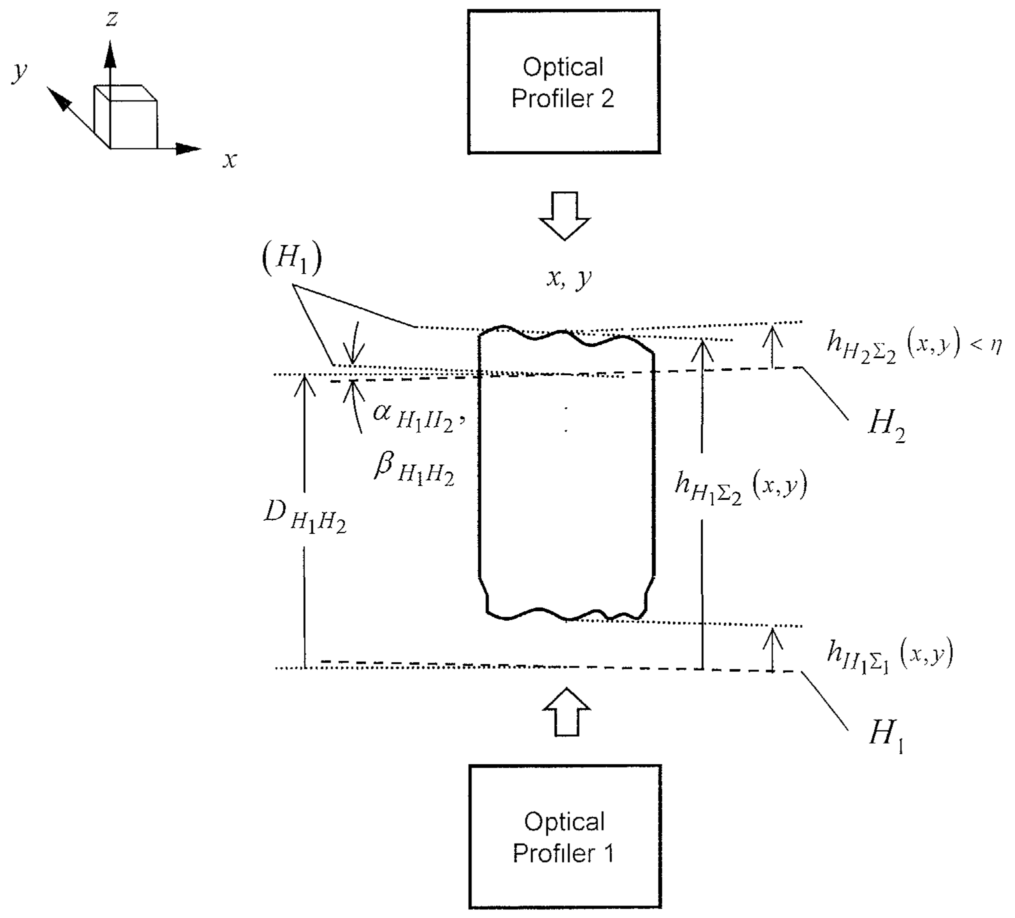
z
y
x
Optical Profiler 2
x, y
(H_1)
$h_{H_2\Sigma_2}(x,y) < \eta$
H_2
$\alpha_{H_1H_2}$,
$\beta_{H_1H_2}$
$D_{H_1H_2}$
$h_{H_1\Sigma_2}(x,y)$
$h_{H_1\Sigma_1}(x,y)$
H_1
Optical Profiler 1

Figure 5

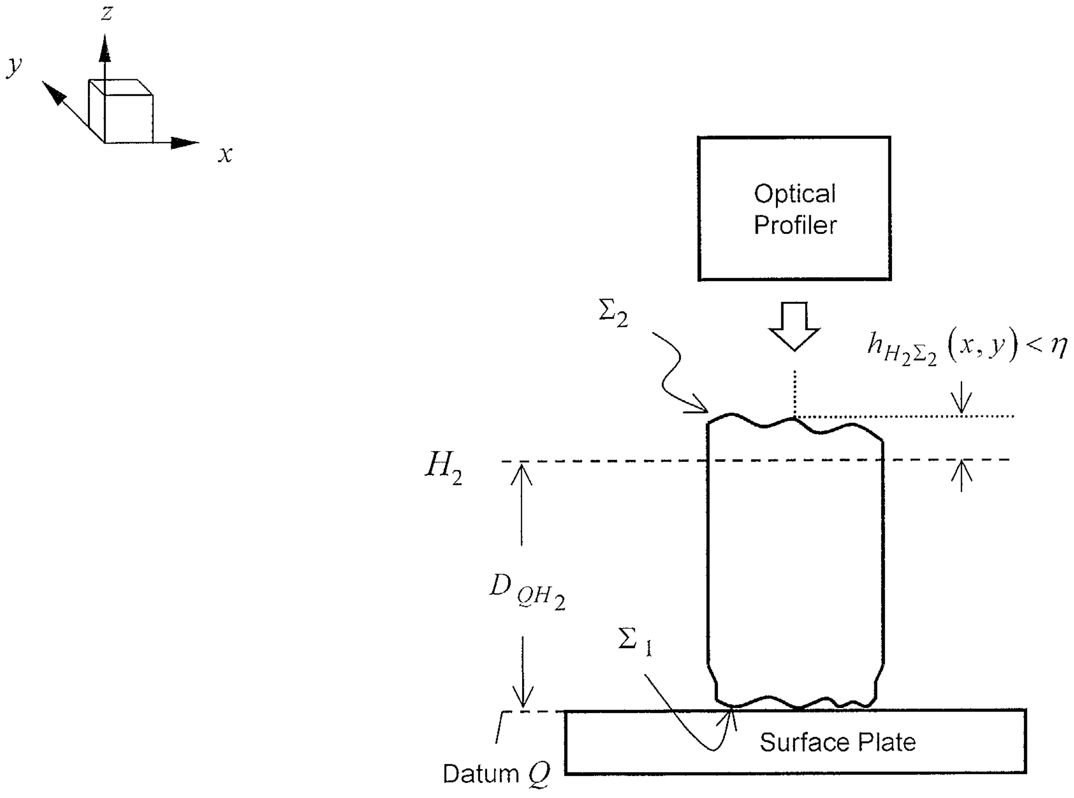
z
y
x
Optical Profiler
Σ_2
$h_{H_2\Sigma_2}(x,y) < \eta$
H_2
D_{QH_2}
Σ_1
Surface Plate
Datum Q

Figure 6

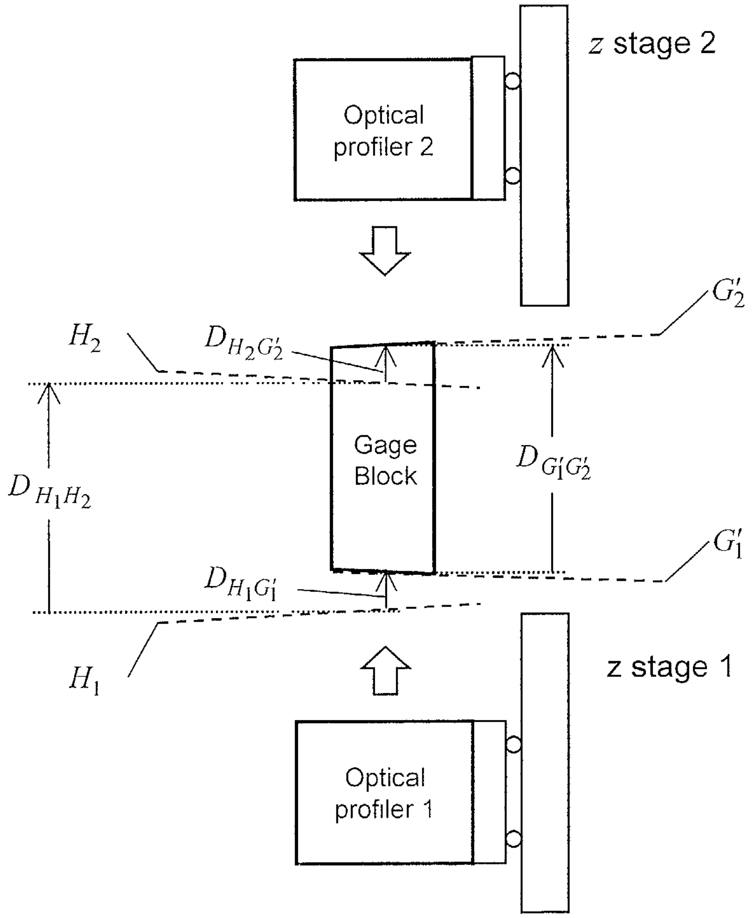
z stage 2
Optical profiler 2
G_2'
H_2
$D_{H_2G_2'}$
$D_{H_1H_2}$
Gage Block
$D_{G_1'G_2'}$
G_1'
$D_{H_1G_1'}$
H_1
z stage 1
Optical profiler 1

Figure 7

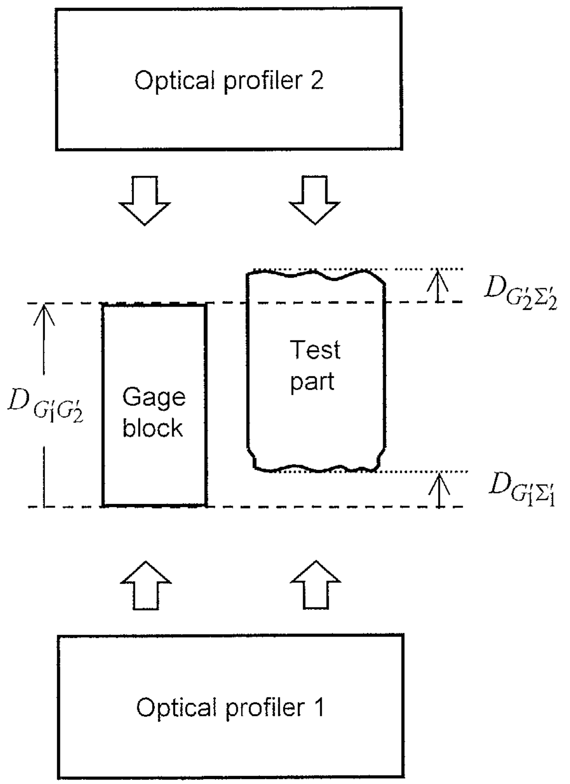
Optical profiler 2
Gage block
Test part
$D_{G_1'G_2'}$
$D_{G_2'\Sigma_2'}$
$D_{G_1'\Sigma_1'}$
Optical profiler 1

Figure 8

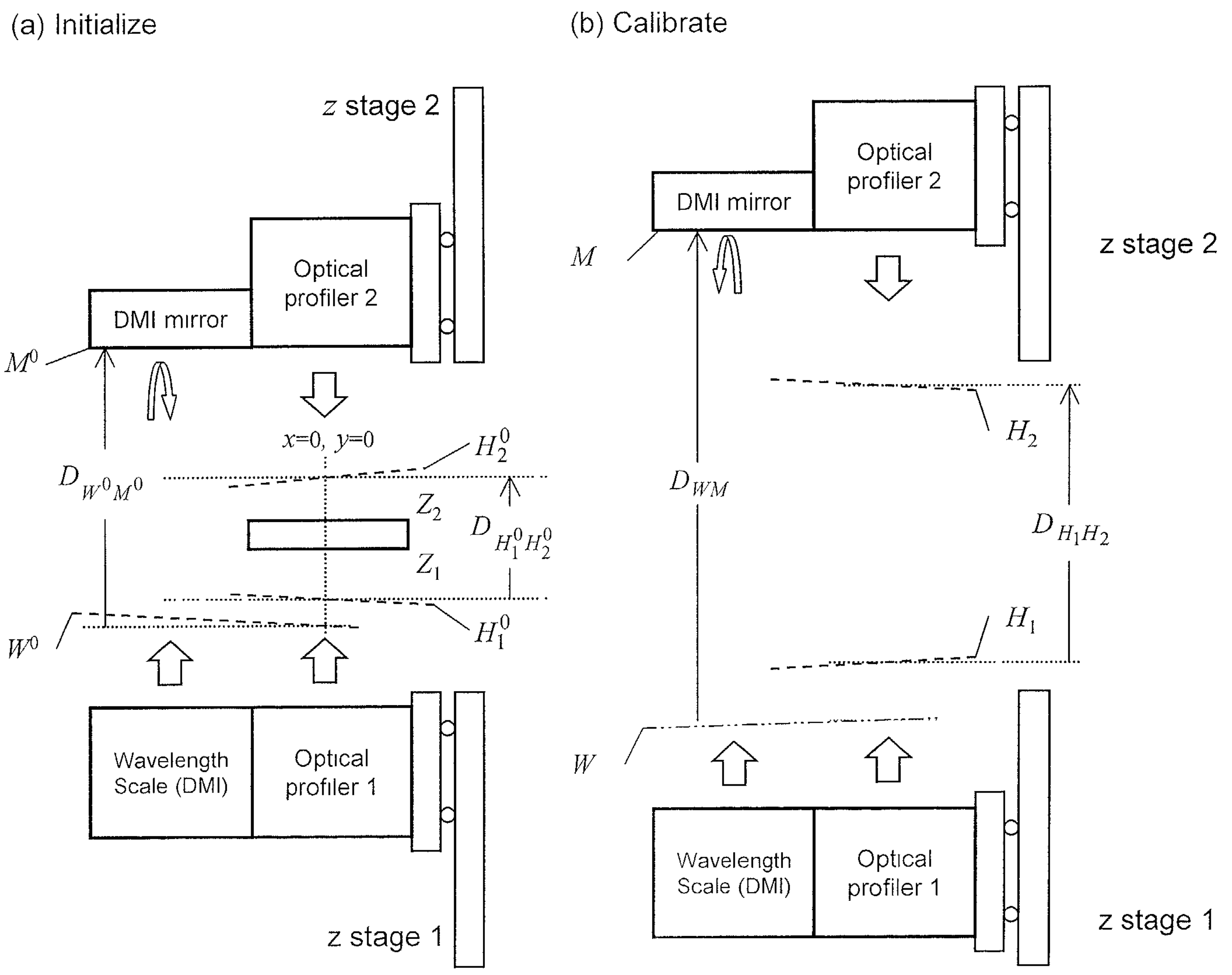(a) Initialize
z stage 2
Optical profiler 2
DMI mirror
M^0
x=0, y=0
H_2^0
$D_{W^0M^0}$
Z_2
$D_{H_1^0H_2^0}$
Z_1
W^0
H_1^0
Wavelength Scale (DMI)
Optical profiler 1
z stage 1
(b) Calibrate
DMI mirror
Optical profiler 2
M
z stage 2
H_2
D_{WM}
$D_{H_1H_2}$
H_1
W
Wavelength Scale (DMI)
Optical profiler 1
z stage 1

Figure 9

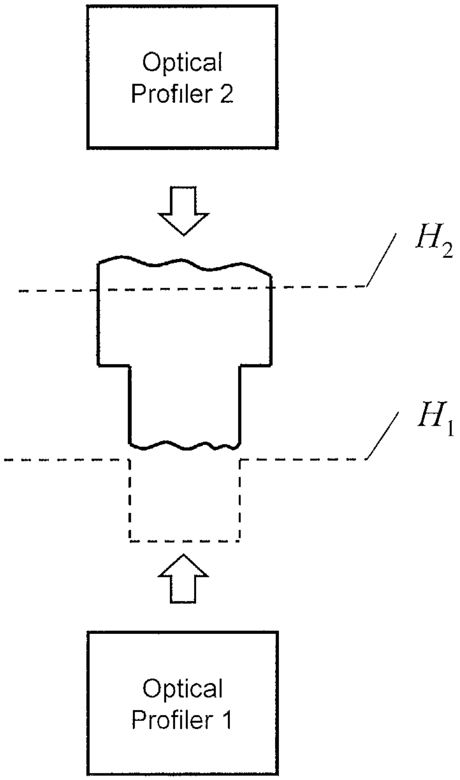

Figure 10

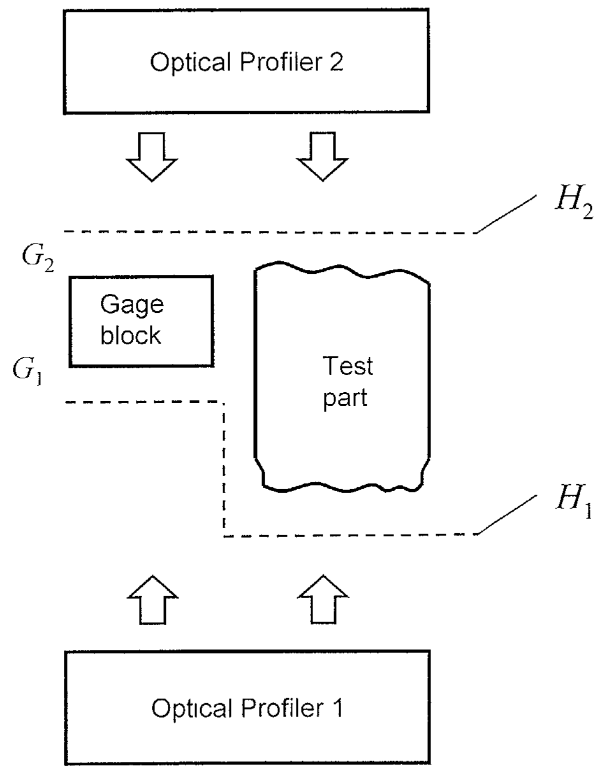
Optical Profiler 2
H_2
G_2
Gage block
G_1
Test part
H_1
Optical Profiler 1

Figure 11

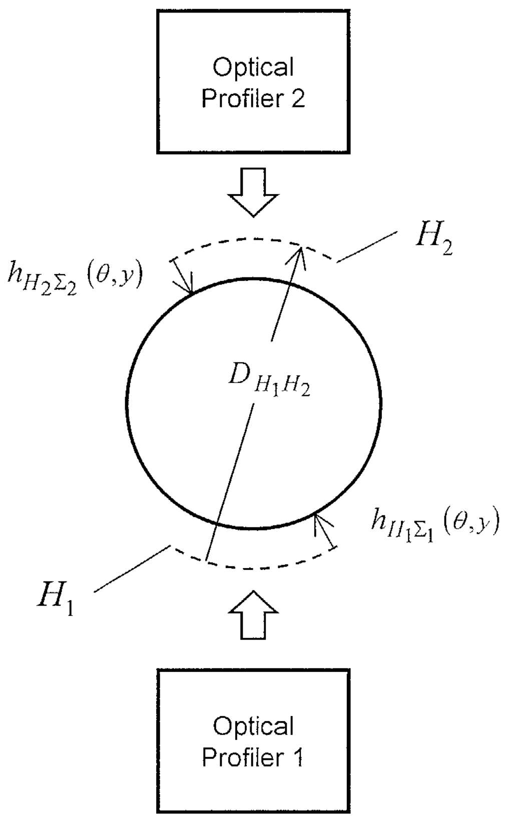
Optical Profiler 2
H_2
$h_{H_2\Sigma_2}(\theta,y)$
$D_{H_1H_2}$
$h_{H_1\Sigma_1}(\theta,y)$
H_1
Optical Profiler 1

Figure 12

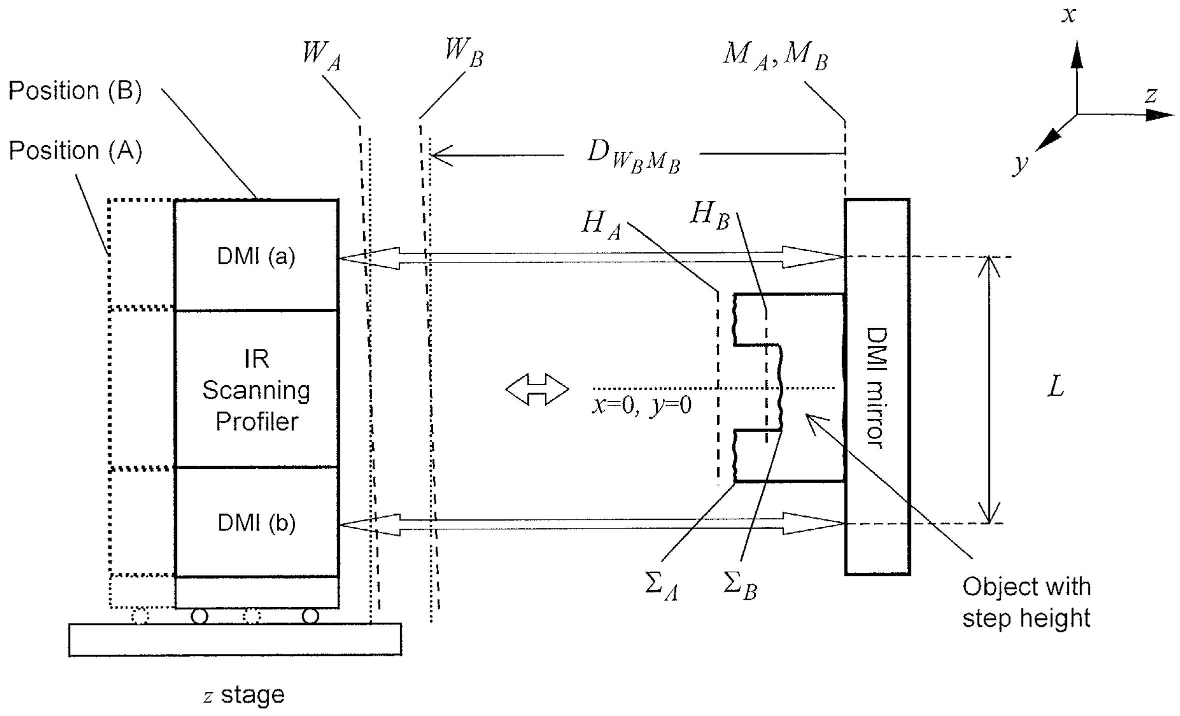
Position (B)
Position (A)
W_A
W_B
M_A, M_B
$D_{W_B M_B}$
H_A
H_B
DMI (a)
IR Scanning Profiler
DMI (b)
$x=0,\ y=0$
DMI mirror
L
Σ_A
Σ_B
Object with step height
z stage
x
y
z

Figure 13

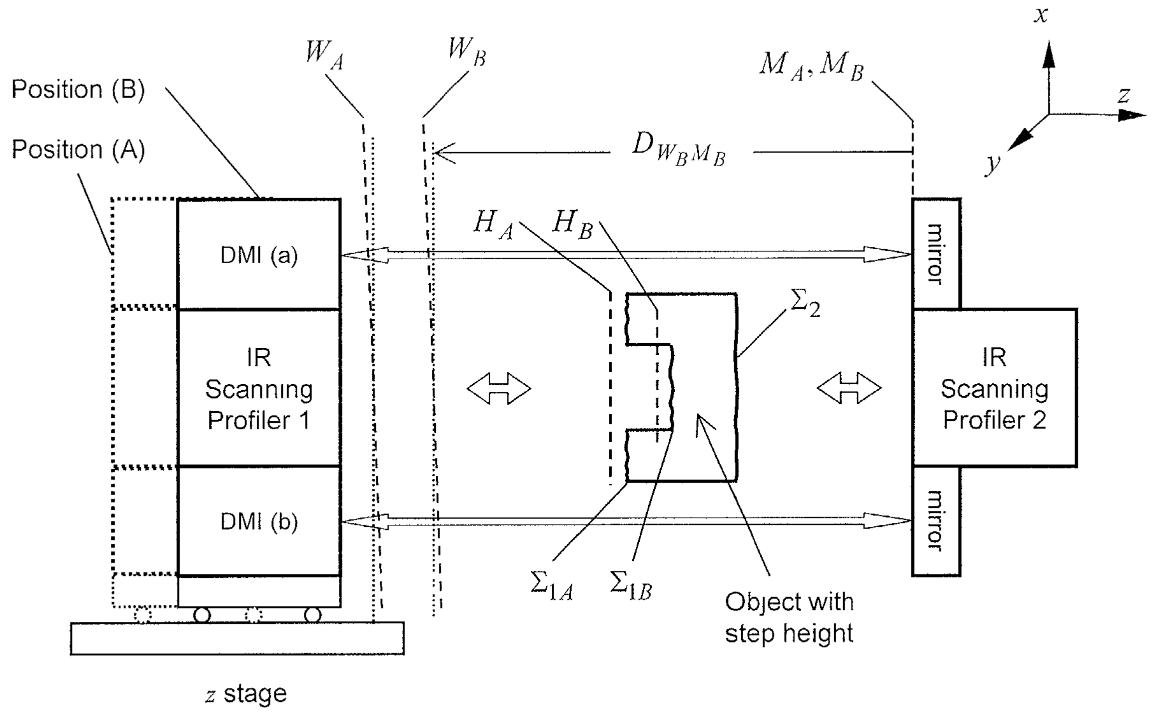
Position (B)
Position (A)
W_A
W_B
M_A, M_B
x
z
y
$D_{W_B M_B}$
H_A
H_B
DMI (a)
IR Scanning Profiler 1
DMI (b)
Σ_2
mirror
IR Scanning Profiler 2
mirror
Σ_{1A}
Σ_{1B}
Object with step height
z stage

Figure 14

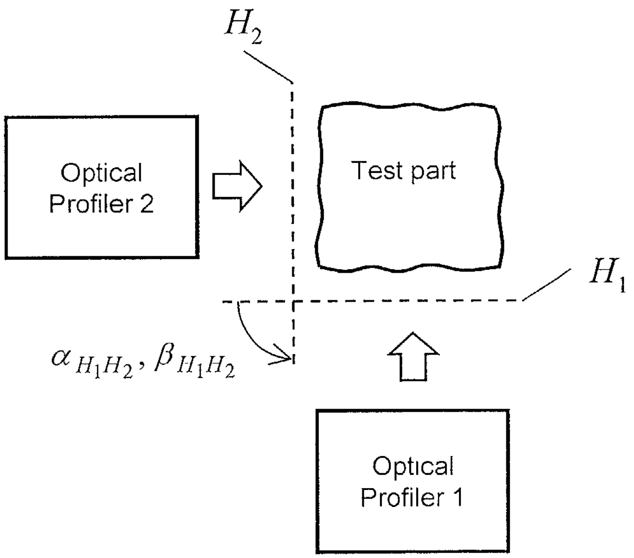
H_2
Optical Profiler 2
Test part
H_1
$\alpha_{H_1H_2}, \beta_{H_1H_2}$
Optical Profiler 1

Figure 15

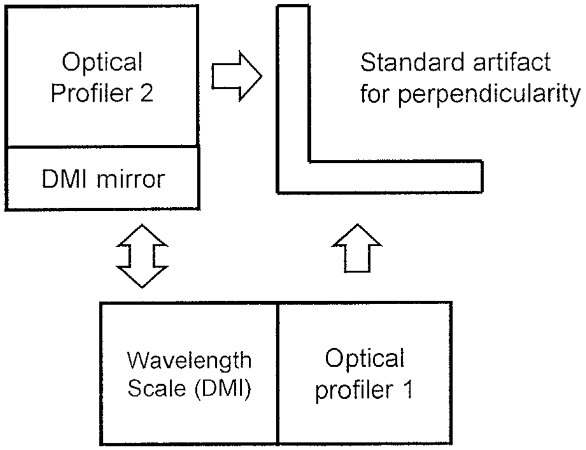
Optical
Profiler 2
DMI mirror
Standard artifact
for perpendicularity
Wavelength
Scale (DMI)
Optical
profiler 1

Figure 16

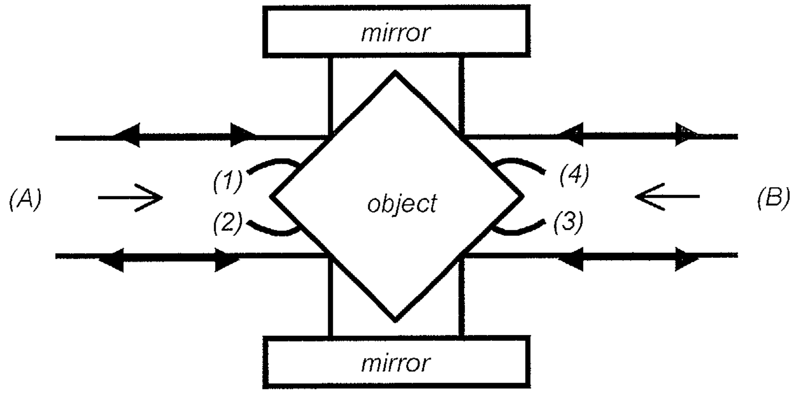

Figure 17

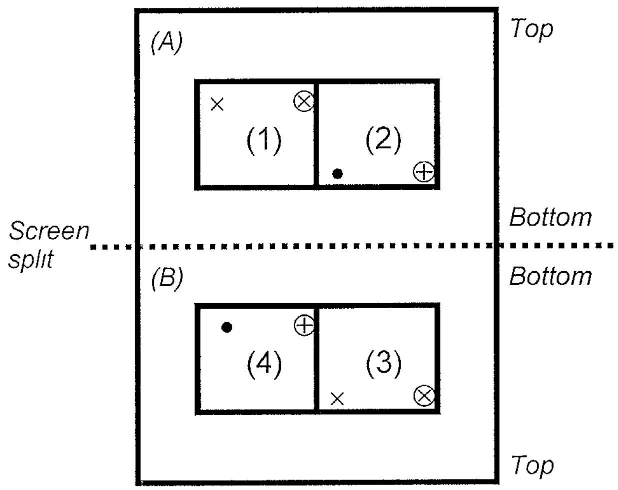

Figure 18

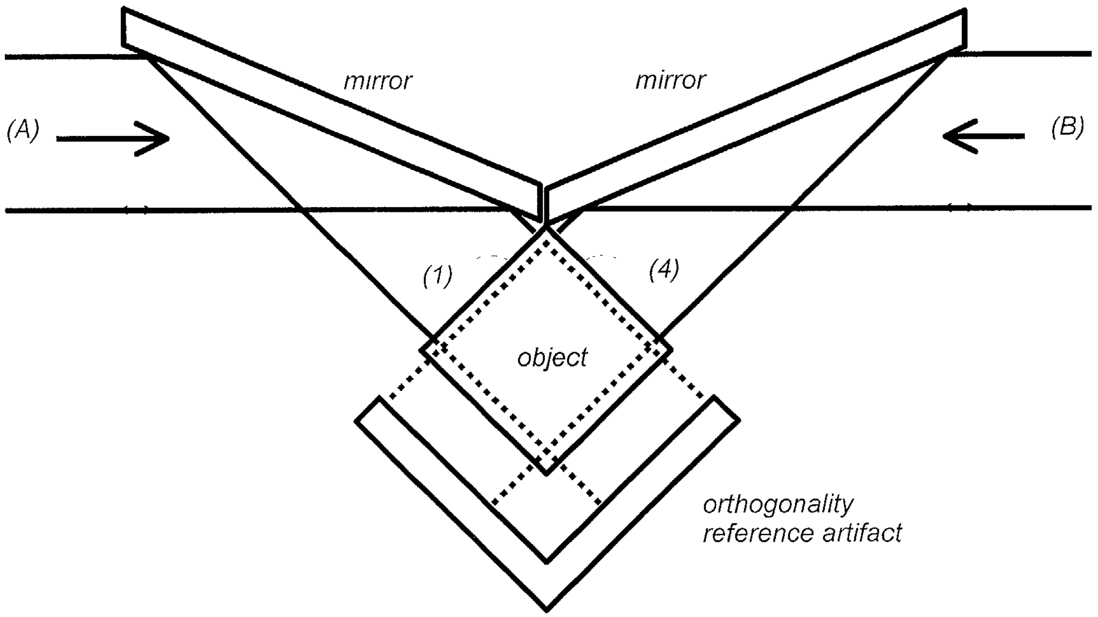
mirror
mirror
(A)
(B)
(1)
(4)
object
orthogonality
reference artifact

Figure 19

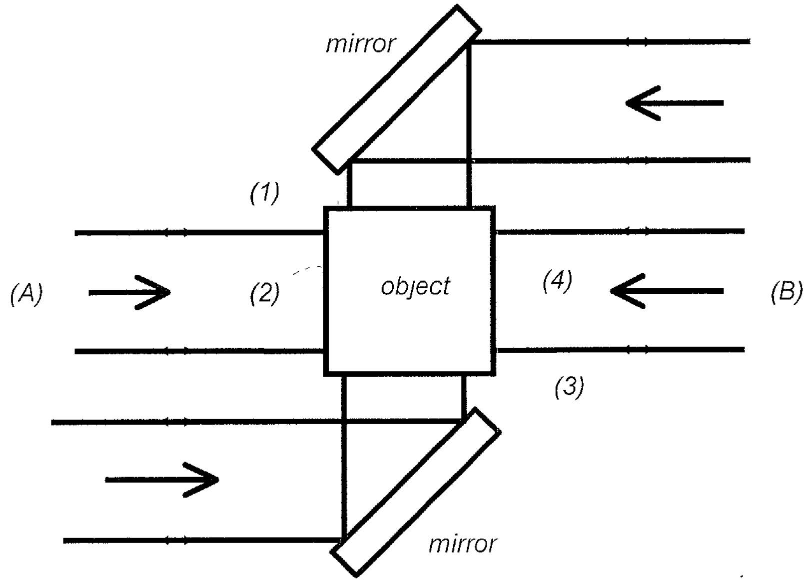

Figure 20

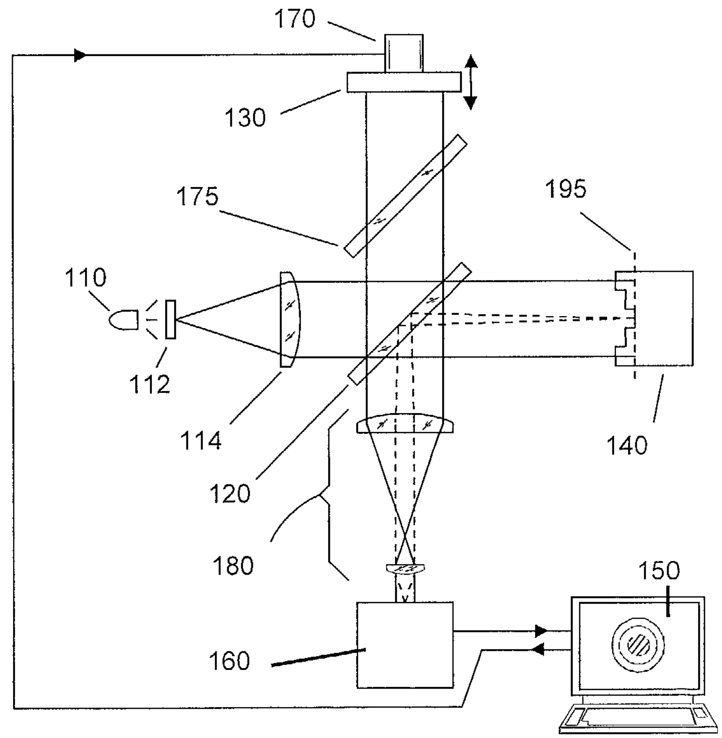

Figure 21

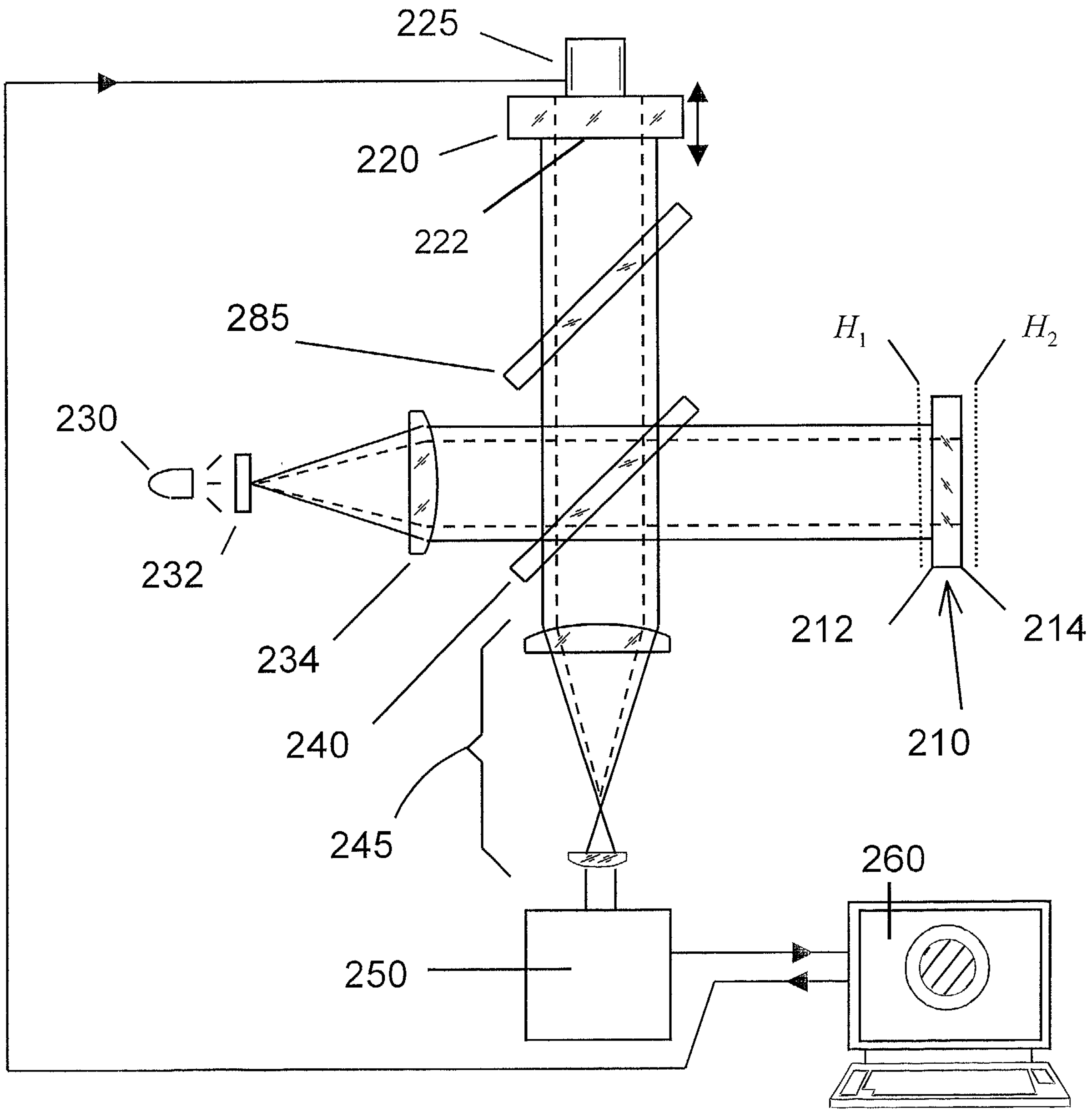

Figure 22

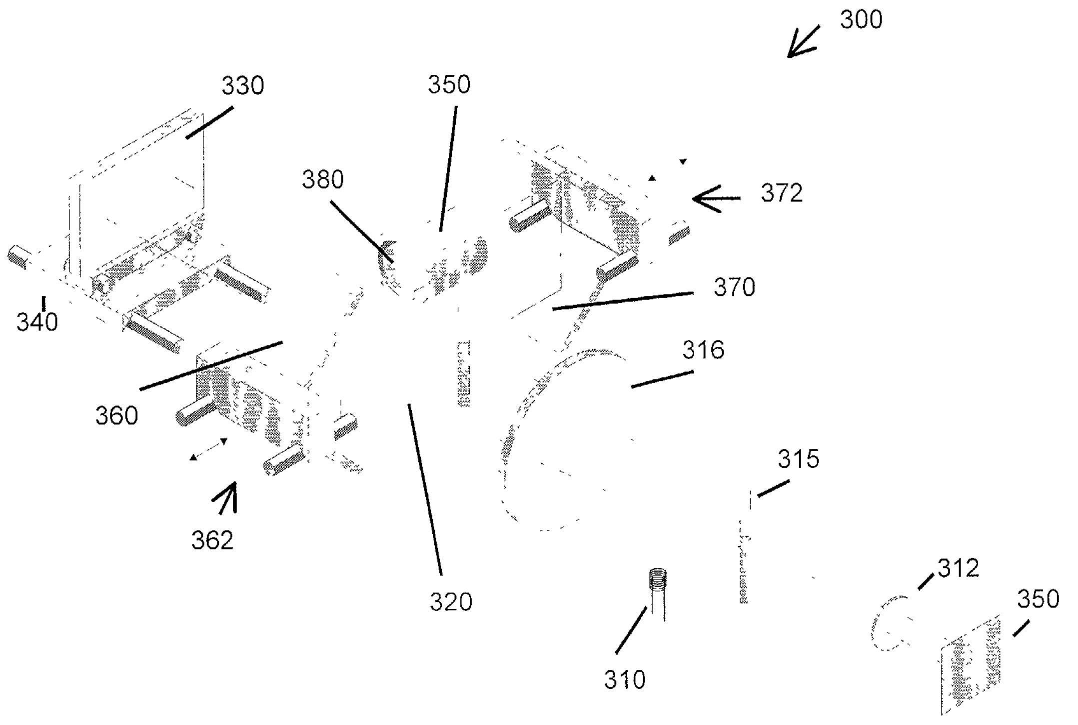

Figure 23

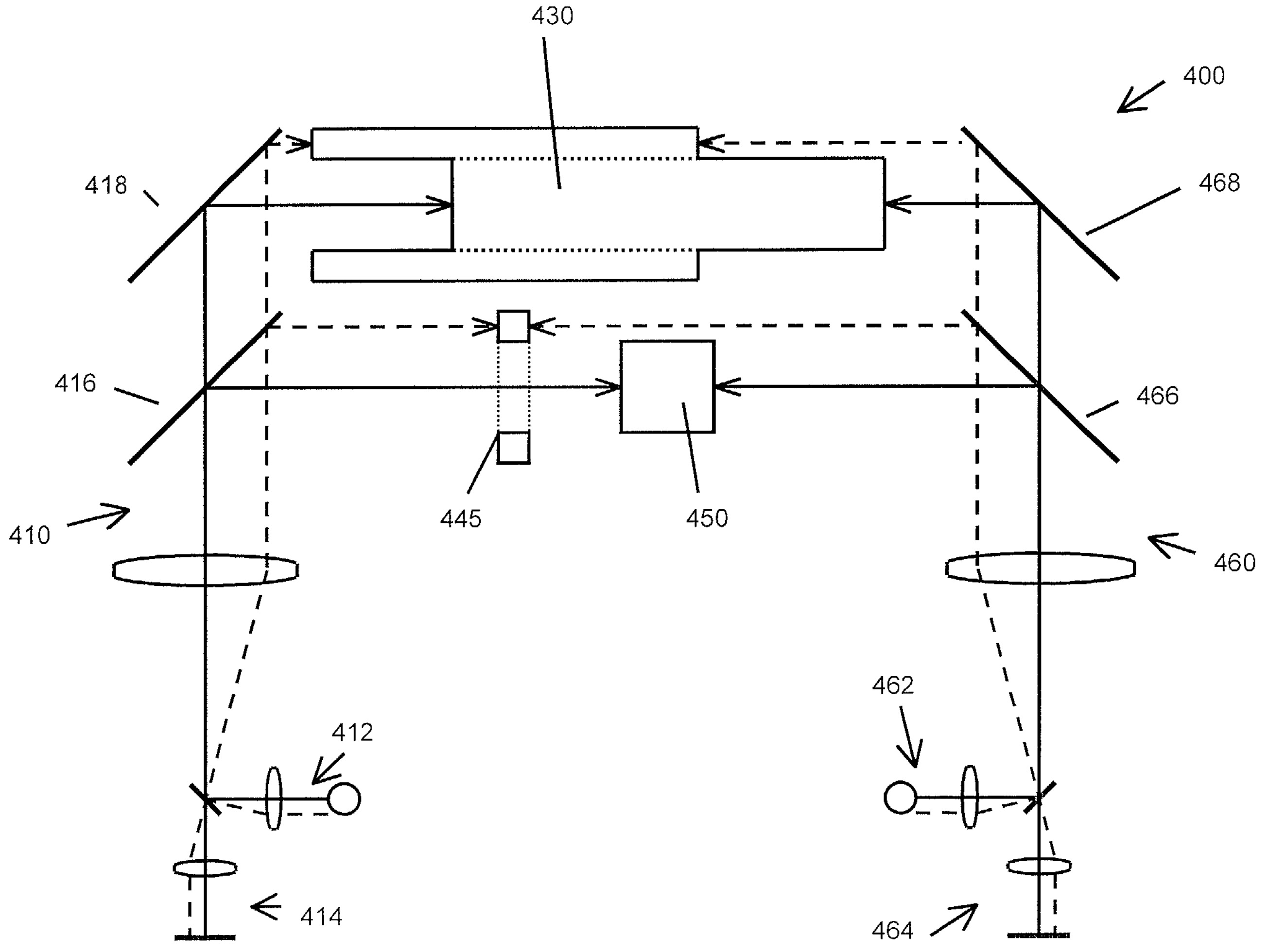

Figure 24

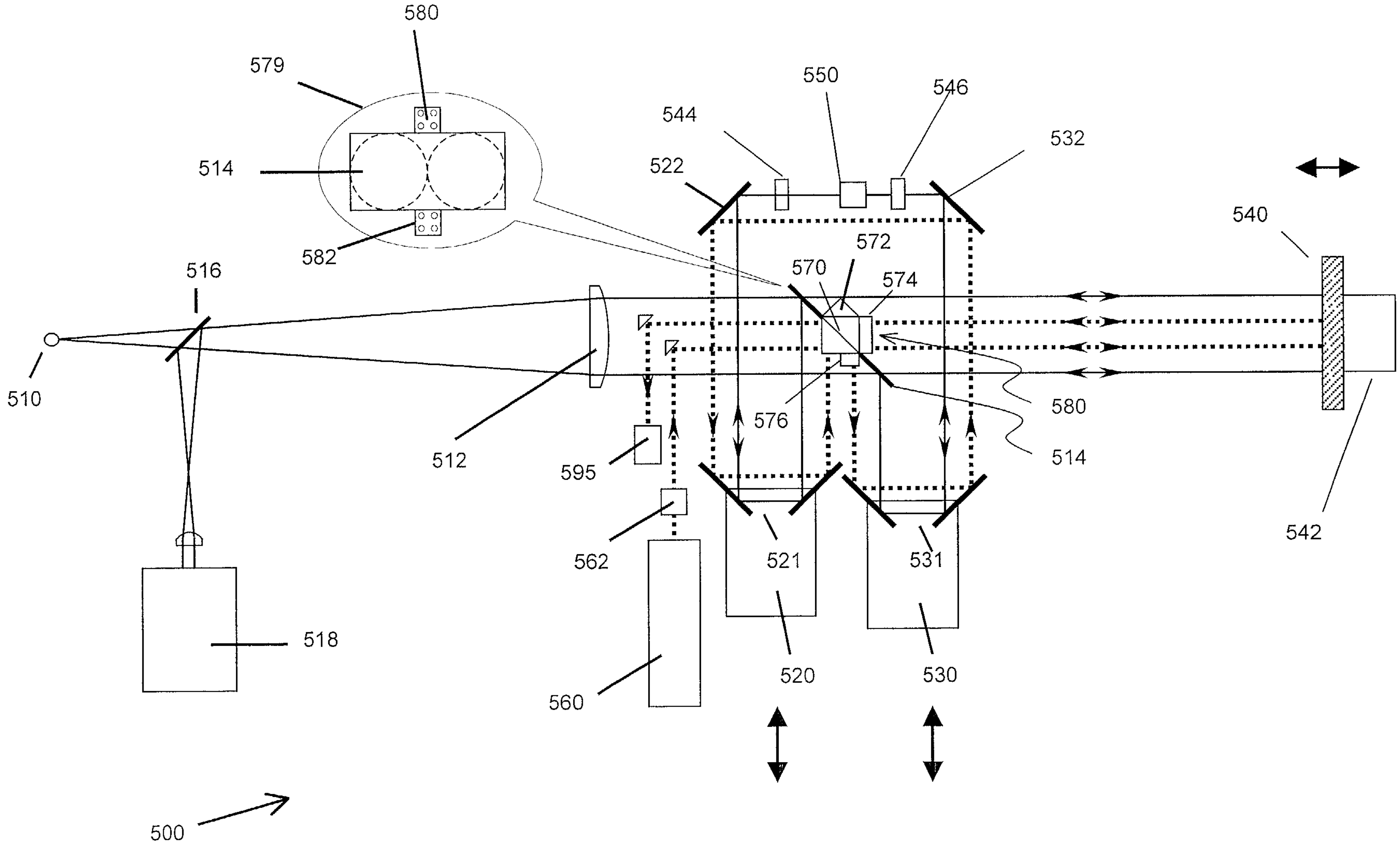
580
579
514
582
516
510
512
544
550
546
522
532
572
570
574
576
580
514
540
542
595
562
560
521
531
520
530
518
500

Figure 25

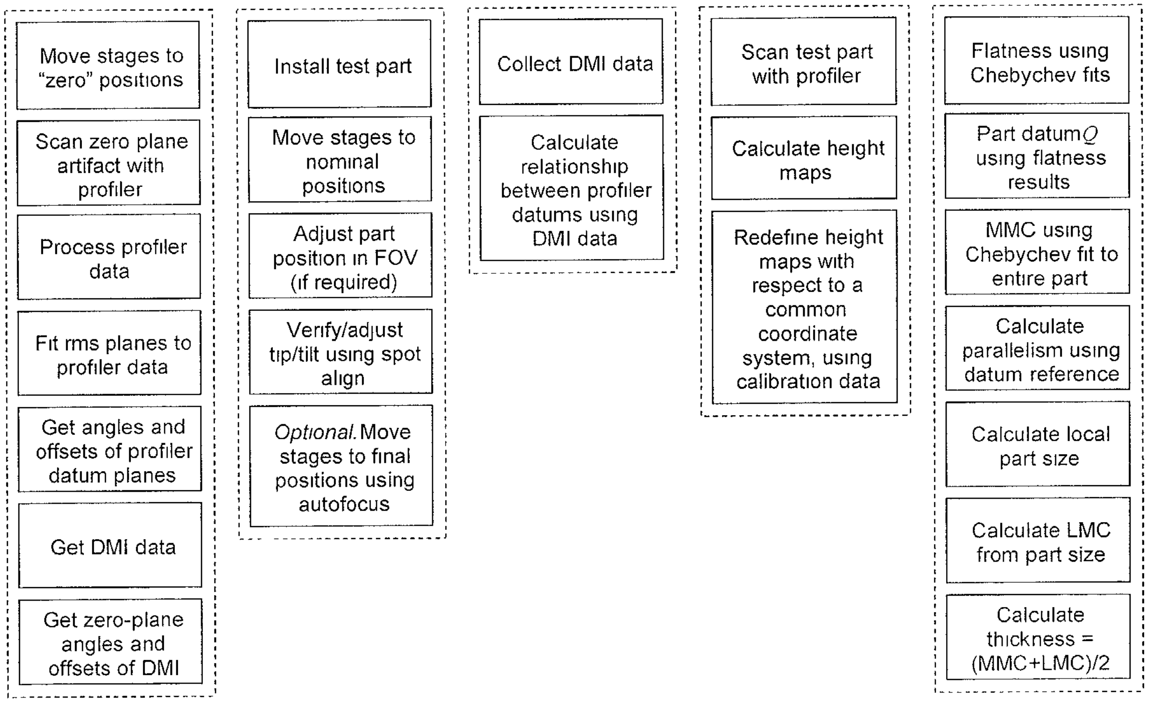
Move stages to "zero" positions
Scan zero plane artifact with profiler
Process profiler data
Fit rms planes to profiler data
Get angles and offsets of profiler datum planes
Get DMI data
Get zero-plane angles and offsets of DMI
Install test part
Move stages to nominal positions
Adjust part position in FOV (if required)
Verify/adjust tip/tilt using spot align
Optional. Move stages to final positions using autofocus
Collect DMI data
Calculate relationship between profiler datums using DMI data
Scan test part with profiler
Calculate height maps
Redefine height maps with respect to a common coordinate system, using calibration data
Flatness using Chebychev fits
Part datum *Q* using flatness results
MMC using Chebychev fit to entire part
Calculate parallelism using datum reference
Calculate local part size
Calculate LMC from part size
Calculate thickness = (MMC+LMC)/2

Figure 26

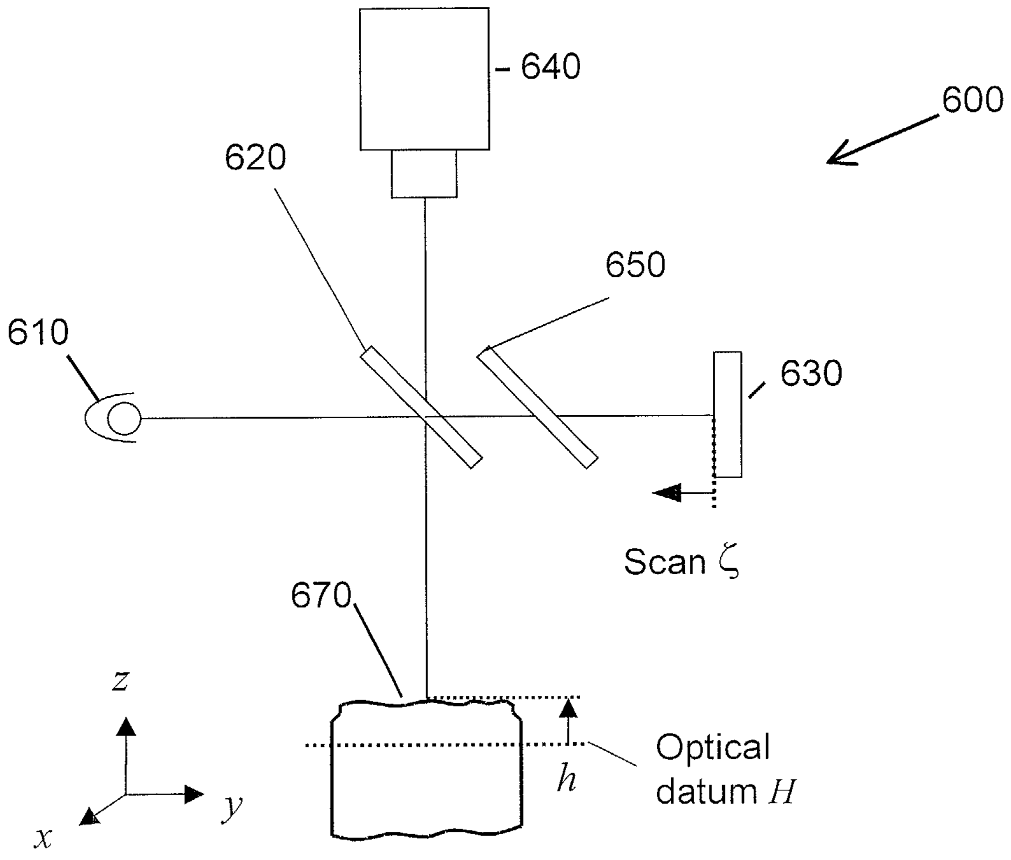

Figure 27

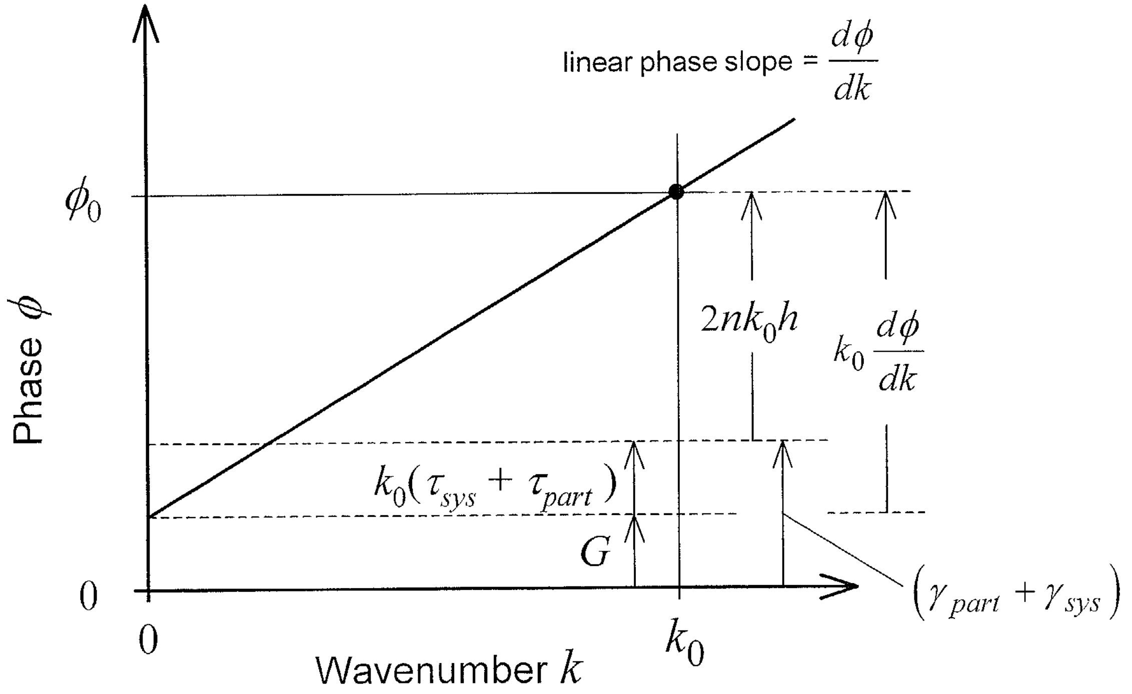
linear phase slope = $\frac{d\phi}{dk}$
ϕ_0
Phase ϕ
0
$2nk_0h$
$k_0\frac{d\phi}{dk}$
$k_0(\tau_{sys}+\tau_{part})$
G
$\left(\gamma_{part}+\gamma_{sys}\right)$
0
k_0
Wavenumber k

Figure 29

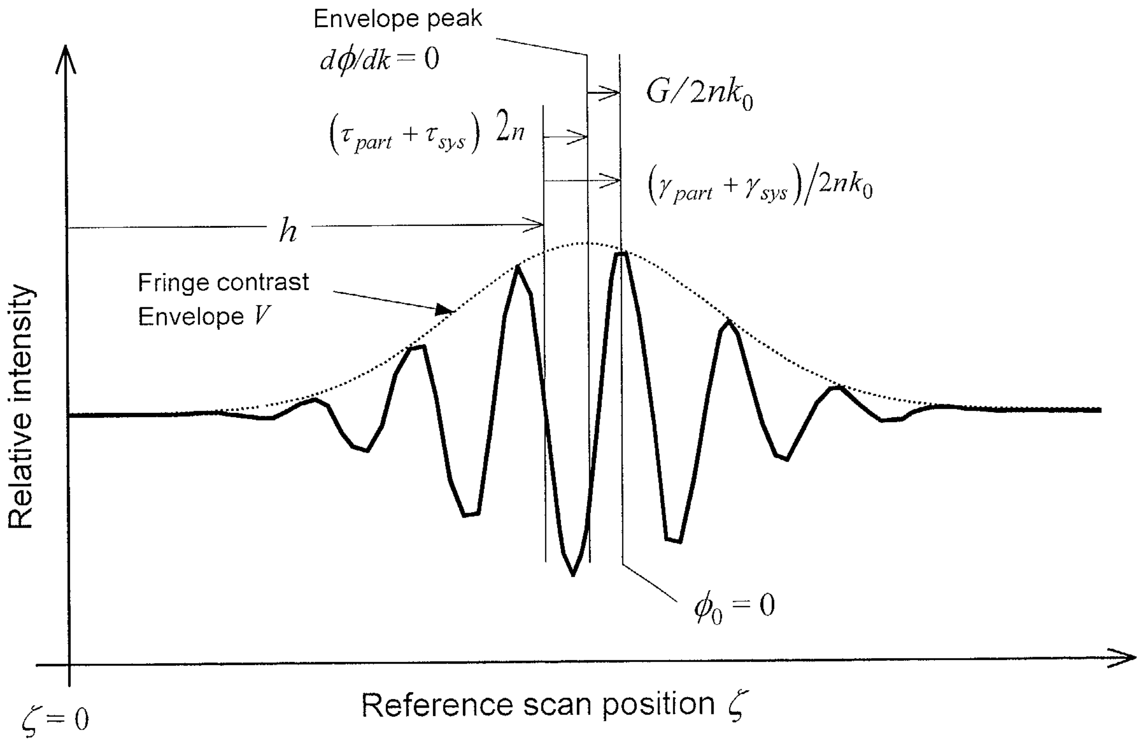
Envelope peak
$d\phi/dk = 0$
$G/2nk_0$
$(\tau_{part} + \tau_{sys})\ 2n$
$(\gamma_{part} + \gamma_{sys})/2nk_0$
h
Fringe contrast
Envelope V
Relative intensity
$\phi_0 = 0$
$\zeta = 0$
Reference scan position ζ

Figure 28